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Ultimatum Games with Incomplete Information on the Side of the Proposer: An experimental Study[1, 2]

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Abstract

In this paper we study ultimatum games with incomplete information on the side of the proposer, which are repeated against changing opponents. The games have the same subgame equilibrium outcome as its complete information version. A proposer has to decide on an offer for the responder without knowing the exact pie size. A responder can accept or not the offer. If the offer is rejected both get nothing. If the offer is greater than the pie size there are two versions of outcome. Either the outcome is not feasible (called ER) or the proposer receives a negative payoff (called NP) if his offer is accepted. We distinguish two negative payoff versions: with starting capital allowance (called NP10) to prevent that a proposer can get total negative payoffs; or without any starting capital allowance (called NP0). We use the strategy method

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[2] This paper is part of the third chapter of the thesis (1993) by Rosemarie Nagel

developed by Selten (1967). We find that offers in NP0 are closer to the subgame perfect equilibrium than ever observed in any ultimatum game. We interpret the behavior as loss avoidance. Responders typically don't reject offers greater than the pie size, which lead to negative payoffs for the proposers. Half of them accept the smallest money amount for all possible pies and the other half respond with strategies that indicate that payoff comparisons are relevant, although proposers don't know the pie size.

1. Introduction

The ultimatum game is probably the most often studied game in experimental economics after the prisoner's dilemma. Its beauty lies in the simplicity of its rules within the area of bargaining and the ease with which one can introduce changes of rules in order to answer a wide range of research questions in the context of social preferences. The most recent survey around this game can be found in Colin Camerer's book (2004)[3].

In a standard ultimatum game, a proposer offers a responder a portion of a cake; the cake is divided in accordance with the offer if the responder accepts, and both players otherwise get nothing. The theoretical prediction that the offer is no more than the smallest feasible positive offer has been readily invalidated[4]. The responders frequently reject non-negligible offers that represent small proportions of the cake. This possibility leads the proposers almost invariably to offer significantly more than theory predicts, with half the cake a typical mode of the data. From the eighties until the midst of the nineties the dispute among experimenters working on the topic was whether behavior was driven mainly by fairness norms or strategic behavior.

One way to gain insights into this behavior is to see what adaptations to the basic ultimatum game structure lead to observations closer to theoretical predictions. We report here perhaps the most successful adaptation observed to date, and discuss inferences thus uncovered for the behavior in standard ultimatum games and in more complex bargaining situations, which may have subgames resembling ultimatum games.

[3] Other surveys are by Alvin Roth (1995), Gueth and Tietz (1990)

[4] Gueth and Tietz (1900), Roth (1995), and Camerer and Thaler (1995) survey antecedent ultimatum game experiments.

In our game, the pie size P is randomly determined. Since the proposer is uninformed about the pie size, it is possible that he will select an offer X > P. The three treatments reported here differ in how that possibility is handled. The first, called ER for enforced rejection, automatically rejects the proposal and constitutes the (0, 0) outcome, thus only allowing the responder to accept offers X ≤ P. The second, called NP0, allows the responder to accept if desired, resulting in a Negative Payoff for the proposer. University regulations prevented enforcement of this measure, but not its announcement. Results below indicate that it had considerable impact. The third, NP10, also allows for Negative Payoffs, but begins the experiment with capital accounts (for both types), which provide a buffer for negative payoffs. All the induced games have the feature that game theory predicts similar equilibrium outcomes for all versions of games. Also the off-equilibrium outcomes in the different versions are alike, except in one version where negative payoffs become possible.

As far as possible, we follow the experimental design of Mitzkewitz and Nagel (1993), who introduced ultimatum game adaptations with a random pie size. In their paper the proposer, but not the responder was informed of the pie size. In order to get as much information as possible from a player we use the strategy method (Selten 1967)[5], ie. both players decide simultaneously giving complete strategies. In our game this means that the proposer has to make an offer and the responder has to say whether he accepts or rejects any possible offer, given any possible pie size (see also the decision sheet of the responder in the design section). Thus, we obtain decision data on all information sets of the game and not only actual choices at those information sets that arise in the course of a play. The structure of an observed strategy allows a deeper insight into the reasoning behind the particular choices. By applying the strategy method we are able to divide the strategies into different classes, which is not always possible when only observing choices (see also Mitzkewitz and Nagel 1993, Knez and Camerer 1995, Selten et al. 1997). However, at least one possible disadvantage could be that a responder might react differently whether he gets an offer for a particular pie size or whether he has to react simultaneously to all contingencies (Roth 1995). However, the general conclusion of the literature up to date is

[5] Actually, the strategy method as proposed by Selten (1967) requires that a subject first is familiarized with the game by responding to a given situation which is arrived by a chance node or a previous decision of an opponent. Only then he will be asked for a complete strategy. However, since we believe that our game is simple enough we omit that first stage.

that in simple games the two different elicitation methods do not produce very different results (see e.g. Brandts/Charness (2000), Güth et al. (2001), Camerer et al. (1996)).

Classifying strategies according to reasoning processes has a rather short tradition in experimental economics. Economists, theorists as well as experimentalists, concentrated for a long time on outcomes rather on processes, as objected by Simon 1978. Nowadays there are an increasing number of papers which try to get a better insight into these processes through mouse lab experiments (see e.g. Johnson et al. 2002, Costa-Gomes, Crawford, and Bruseta 2001), through the collaboration with neuro- scientists (see Camerer et al. forthcoming on neuro-economics), or written comments (see e.g. Bosch, Garcia Montalvo, Nagel and Satorra, 2002). This paper adds to the literature by exploiting the advantages of the strategy method.

One difference to Mitzkewitz and Nagel (1993) is that we introduce the so called «double-blind procedure», i.e., the observation of a subject by the experimenter is reduced as much as possible: in particular, the experimenter never knows the identity of a subject when seeing a decision and the subject knows and realizes easily from the procedure that anonymity towards the experimenter is guaranteed. We use this design feature, because we do not want to ignore the fact that there was a difference in behavior depending on whether a subject's behavior could be identified by the experimenter (though not by the subject he was interacting with) or whether this surveillance was removed (see e.g., Hoffman, McCabe, Shachat and Smith (1994), who study the behavior in dictatorship games). However, since Bolton and Zwick (1993) provide an experiment in which the difference in design of anonymity versus experimenter observation does not produce a significant effect in a simplified ultimatum game we do not use the «double blind procedure» as a treatment variable.

Another difference to the design of Mitzkewitz and Nagel (1993) is that the size of all cakes is doubled: thus, they are 2, 4, 6, 8, 10, or 12 Taler with equal probability. We use this distribution rather than the former, in order to restrict the offers, a responder may hear, to integers. We believe that this linear transformation does not make any difference and that this is not a contradiction to the Rapoport et al. (1996a,b) results since there the mean cake size remained constant whereas the variance was changed. When comparing results with experiments of Mitzkewitz and Nagel (1993), we normalize their results to the cakes 2, 4,...,12.

In section 2, we define the games under consideration and discuss the game-theoretic solutions. In section 3 we present the experimental design. Section 4 presents the results aggregated over the eight repetitions. Section 5 studies the dynamics of the behavior over time. Section 6 summarizes the main results.

2. The model and the game theoretic solution

In the following we describe the extensive form of the one shot game of the different versions of the ultimatum game with incomplete information on the side of the proposer and its game-theoretic solutions. The proposer, not knowing the size of the pie makes an offer to the responder who knows the pie size. The responder can accept or reject. Since the proposer does not know the actual pie size, when making a proposal, we call his offer a «*blind offer*» and the games, we are analyzing, we call *blind-offer games*[6]. We distinguish between two versions of continuation of the game when the offer is greater than the pie: 1. a «*nonfeasible*» version, also called enforced rejection (abbreviated «ER») version, i.e. the opportunity to split the pie additionally vanishes when the offer is greater than the pie size, and 2. a «*feasible*» version, also called negative payoff (abbreviated «NP») version, i.e. the opportunity to split the pie only disappears when the responder rejects. Next we describe the rules of the game in detail.

1. The pie may be one of six amounts: 2, 4, 6, 8, 10 or 12 taler, a fictitious currency. Throwing a die and doubling the amount thrown determine its size. 1 taler is equivalent to 0.70 DM. At the time of the experiments this was worth about $ 0.40.
2. The responder is informed of the pie size. The proposer knows only how the size of the pie is determined, but is not informed of the actual throw of the die.
3. The proposer proposes an offer to the responder. *The offers are restricted to the set {0, 1, 2,..., 11, 12}*.

In the nonfeasible case (ER-treatment):

[6] We don't study demand games (the proposer requires an amount for himself) since the equilibrium structure in that game is slightly different from the structure of the other ultimatum games. The reader is referred to Forsythe, Kennan, Sopher (1991).

4a. If the offer is not feasible (the offer is greater than the pie), the game ends and both get nothing.
4b. If the offer is feasible, the responder can accept or reject it.
5. If the responder rejects the proposal, both receive nothing. If he accepts the proposal then the proposer gets the whole pie minus his offer, and B receives the offer.

In the «all feasible» case (NP-treatment):

4'. The responder can accept or reject the offer.
5'. If the responder rejects the proposal, both receive nothing. If he accepts the proposal then the proposer gets the whole pie minus his offer, and B receives the offer.

Thus, in a blind-offer game, the proposer is not informed about his possible payoff when making his decision. Item 5' implies that the proposer may obtain negative payoffs when his offer is greater than the pie available. In the «nonfeasible» version this cannot happen.

Unlike in the games described in Mitzkewitz and Nagel (1993)[7] not every strategy of the proposer may be a part of an equilibrium strategy. In the non-feasible version, to any choice of the proposer one can find a strategy of the responder such that a Nash-equilibrium-point results. In the feasible version this holds only for choices not larger than 7. A choice exceeding 7 cannot be an equilibrium strategy for the proposer, because his expected gain would be smaller than zero.

The concept of the subgame-perfect equilibrium reduces the number of equilibria to those equilibria in which the responder obtains no more than one taler. Subgame-perfect equilibria in which the responder accepts zero offers at some pies are extre-

[7] Since we make so many references to the offer and demand game of Mitzkewitz and Nagel (1993), we describe here the rules of these games: in the offer game the proposer knows that the pie is either 1, 2…., 6. He makes an offer to the responder, who can accept or reject, only knowing the distribution of the pie. In a demand game the proposer makes a demand for himself, which the responder can reject or accept, knowing the distribution of the pie and thus not knowing the exact amount offered to him. A strategy of the proposer consists of an offer or demand for each possible pie and a strategy of the responder consists of saying yes or no to each possible offer or demand which could be 0, 0.5, 1… to 5.5, 6.

mely weak since the responder loses nothing when rejecting zero. Therefore as for the offer game in Mitzkewitz and Nagel (1993) we only consider the path-strict equilibrium in which the proposer offers 1 taler and the responder accepts all positive offers at each pie[8]. Note that the possibility of negative payoffs does not change the path-strict subgame-perfect equilibrium of the one-shot game.

3. The design

We ran 12 sessions with 190 students in total from various departments of the University of Bonn in the summer of 1993. The same instructions (see Appendix I) were read to all subjects participating in the experiment before they knew their role. Afterwards, the subjects were separated into two groups of 8 by their own draw of colored chips from an envelope, and moved into large separate rooms. A hired assistant in each room made certain that subjects were widely spaced, but subjects were free to select their own seat. Only then subjects learned which room was for the proposers (called «Players A» in the experiment) and which for the responders («Players B»).

Each subject participated only in one version of the game, always in the same role. The same game was played for 8 rounds, against changing opponents. In order to maintain *anonymity between experimenter and subjects* we imposed a double blind procedure. The procedure was as follows: After being seated, each participant drew a set containing a folded decision sheet with an opaque cover with a 3-letter fictitious name at the outside, so that the content could only be seen when unfolded; an explanation sheet and a card, on each of which was written the same fictitious name (for example SAS, RAF, LOB. When the set was drawn, the experimenters did not see the name written on a sheet. After a round, each subject folded the decision sheet in the middle with the written decisions in the inside and handed the sheet to the assistant without showing the fictitious name on the outside of the sheet. After all decision sheets where handed in, they were taken to the experimenters who were sitting at a desk in the hall midway between the two rooms. With this method, without undertaking a complicated procedure, the assistant did not know a player's decision or his fictitious name and the experimenter did not know the players' identity. Also, the subjects

[8] In Mitkewitz and Nagel (1993) the selected equilibrium is a sequential equilibrium, since the responder has only one information set and therefore there is only one subgame, but many subgame perfect equilibria.

easily understood this kind of anonymity. After the matching procedure of each round similar to the one described in Mitzkewitz and Nagel (1993), the assistant returned a box containing the decision sheets and had each subject retrieve his own sheet. This was made certain by asking the subjects whether they had their own sheet in hand, after the last subject had received his sheet[9].

At the end of the 8th round, *a double blind procedure was used to pay subjects*. The experimenters calculated subjects' earnings. The appropriate amount of cash was placed in an opaque box with the subject's fictitious name at the outside, along with a denominated receipt (that is, a receipt indicating the amount of money earned). We used as many paper bills as possible in order to reduce the weight and rattle of a box indicating its contents. The hired assistant in each room then had each subject take one of the boxes from a large box, but did not yet give subjects permission to open their boxes. After the last subject had a box, they were asked if each was satisfied that he held the correct box for him. If not, all boxes were re-collected and this process was re-run. When all were satisfied the boxes could be opened. Each subject was asked to sign his denominated receipt only with his fictitious name (thus, there was a receipt for, say, 22.40 DM signed «JAT»). In addition, each subject signed an undenominated receipt, with his real name, certifying that one of the 16 denominated receipts was in fact signed by him under one of the 16 names listed. This signing procedure was necessary in order to have detailed financial records acceptable to the funding institution.

The reason for undertaking the «double blind» method is that it has been shown in some experiments that the presence of the experimenter or the possibility of being identifiable, effected the behavior of subjects in a certain direction (see e.g. Hoffman, McCabe, Shachat, Smith 1992). However, we do not use a procedure without anonymity towards the experimenter, thus we do not investigate whether we would have obtained different behavior. Instead, we just take the consequences out of those studies and use a method, which hopefully prevents possible experimenter effects. Nowadays this method is rarely used since it is very cumbersome. Usually if there is enough interaction between subjects the experimenter effect should be rather small.

[9] It is likely that at some time the hired assistant saw the fictitious name and could associate it with the player's face. Similarly, the next-to-last subject taking his decision sheet learned this association for the last person. These features seem unimportant since no information of the decision is ever revealed.

Since in the all feasible treatments a proposer could be left with negative payoffs at the end, we conducted two negative payoff treatments: one with no starting capital balance (we will call it NP0) and one with starting capital balance of 10 talers (NP10). The number refers to the size of a starting capital balance (in talers).

The NP10-experiments paid both the proposers and the responders their earnings plus the starting capital balance of 10 talers. Subjects were told that if any the proposer after any round had lost so much money that his current balance had fallen to 0 or less, that subject would be removed from the experiment. We were careful to set this up in a way that gave the subject the right to maintain his anonymity. We had prepared sheet with a message «your balance has fallen to 0, and therefore you cannot further participate.» He would not be forced to stay; but he could stay and simply pass in his folder each round if he wished. We informed subjects, in answer to questions, that in the event of a bankruptcy, the responder who was to be paired with a bankrupt the proposer would have his payoff determined by a match with a randomly chosen other the proposer. No subject went bankrupt in the NP10 treatment.

In the NP0 experiments, no subject would be removed, but subjects were told that they were expected to pay any negative ending balance out of their own pocket. We responded to questions by insisting that this was an obligation of subjects. We had no additional enforcement mechanism to actually obtain those payoffs from a subject who got negative payoffs[10]. In fact, 2 of the 32 the proposers in the NP0-experiments finished with negative balances. One who owed 7.70 DM (about $4.50) left without paying; the other put the 5.60 DM owed in his box and signed a receipt for 5.60 DM with his fictitious name.

We conducted 4 sessions on the «Enforced Rejection»-treatment (abbreviated «ER», sessions 1-4), and 4 sessions on the «Negative Payments»-treatment NP0, (sessions 5-8) and 4 sessions on the «Negative Payments»-treatment NP10 (sessions 9-12). In all but one session, 8 of the subjects were the proposers and 8 were the responders. In one NP0-session (session 8) only 14 subjects showed up[11]. In one NP10-session (session 10) one player B did not return his decision sheet. Because of the

[10] Usually, in experiments in which a subject has to pay out of his own pockets, experimenters run several experiments before which are only paid at the very end of the series. This way a subject may lose his own money which he has, however, earned before. See for example Bosch and Silvestre (2003).

[11] In the group with 14 subjects they also played 8 rounds. In the third round they were matched as in the first round and we told them after that round that from the remaining rounds no player would be rematched with the same person again.

double blind method explained below we cannot trace his identity, thus this person's decisions have been lost.

As in Mitzkewitz and Nagel (1993) we applied the strategy method. This means that the proposer had to hand in just one number out of the set {0, 1,...,12} in a period (figure 1a). The responder had to fill in a matrix, indicating for each pie size those offers he wants to accepts by block underlining them (see figure 1b) before knowing the actual pie of the round or the decision of the proposer. Note that, in the nonfeasible version, decisions on nonfeasible offers (offer is greater than pie size) are irrelevant, and therefore we do not ask for them.

Figure 1a. Decision sheet of Player A (the proposer), with 8 lines for the 8 periods

Decision sheet Player A

Date: 23.6.1993 Fictitious
Name:

Round	Your offer to Player B:
1	
…	

Figure 1b. Protocol sheet of Player B (the responder). The one for Player A (the proposer) is similar with the field for the sum under the column «Period-payoff A»

Player B Record Sheet (ER-treatment)

For the «Negative Payments»-treatment (NP0, sessions 5-8) with NO=0 capital balance
Date: ___ Fictitious Name: ___

Round: 1

Total Amount	Please Block Underline Acceptable Offers For Each Total Amount (└──────┘)												
2	0	1	2										
4	0	1	2	3	4								
6	0	1	2	3	4	5	6						
8	0	1	2	3	4	5	6	7	8				
10	0	1	2	3	4	5	6	7	8	9	10		
12	0	1	2	3	4	5	6	7	8	9	10	11	12

Figure 1b. Protocol sheet of Player B (the responder). The one for Player A (the proposer) is similar with the field for the sum under the column «Period-payoff A» *(Cont.)*

Player B Record Sheet (NP-treatment)

Date: ___ Fictitious Name: ___

Round: 1

Total amount	Please block underline acceptable offers for each total amount (⌊________⌋)												
2	0	1	2	3	4	5	6	7	8	9	10	11	12
…	0	1	2	3	4	5	6	7	8	9	10	11	12
12	0	1	2	3	4	5	6	7	8	9	10	11	12

Figure 2. Protocol sheet of Player B (the responder). The one for Player A (the proposer) is similar with the field for the sum under the column «Period-payoff A»

Protocol sheet

Date: 14.10.1993
Fictitious name: MUB

	Total amount	Offer Player A	Response Player B	Period-payoff A	Period-payoff B
Period 1					
2					
etc.					
Sum of payoffs over all rounds in Talers					

When all subjects had finished their decisions in a round, all decision sheets were collected. The round specific pie size was determined by having a randomly picked subject roll a die, in the responders' room in odd-numbered rounds, else in the proposers' room. In both rooms, the throw was made known. Figure 2 shows the information a player receives in a round. Thus, no player was informed about other pairs' histories the proposer. The proposer was not informed of the complete strategies of the opponent, which is a typical method up to day.

4. The results

4.1. *Results pooled over all periods*

A. Choices of the proposers

In each round, the proposer makes one offer to an anonymous responder. Tables 1 a, b, c display the frequencies of choices of each session within the ER-, the NP10-, and the NP0-treatment, respectively, pooled over 8 periods; figure 3 plots the cumulative relative frequencies of the offers, separately for each of the three treatments. Choices above offer 4 are only chosen between 15% and 19% in the different treatments. In the ER-experiments about 60% of the observations are offers 3 or 4. Thus, half of the expected pie might be a decision rule many subjects go by. In the NP10-experiments modal offers are offers 2, 3, or 4. In the NP0-experiments, nearly 50% of the choices are either offers 1 or 2 and only about one third of the data are concentrated at offers 3 and 4. There is a significant difference comparing modal choices between NP0-sessions and the ER-sessions, on a 5% using Mann-Whitney U-Test. There are no significant differences between the other comparisons.

Subgame-perfect equilibrium choices are rarely observed, however, the NP0-treatment produces more choices at equilibrium and near equilibrium (here: choice 2) than has been ever observed in other ultimatum games. The frequency of choice 2 is significantly higher than those in the ER-sessions (at the 5%-level, according to Mann-Whitney U test). Since low choices are mainly observed in one treatment, we do not interpret it as maximization behavior or close to maximization behavior, but rather as loss avoidance. Thus, negative payoffs reduce choices more likely than the possibility of non-feasible choices in ER, which induced zero payoffs. Game theoretically there should be no difference in behavior.

Result 1: In the ER-treatment modal choices are at choice 3 or 4 (60%), in the NP10 treatment it is at 2, 3, or 4 (70%) while in the NP0 treatment it is at 1 or 2 (50%), as low as it has never been observed in these kind of experiments. We interpret 3 and 4 choices as expected fairness choices (half of expected pie size), while 2 is a loss avoidance choice.

offer	ER-sessions 1	2	3	4	total	Relative frequency
0	3	0	1	1	5	0.02
1	6	4	0	0	10	0.04
2	15	15	5	3	38	0.15
3	9	<u>21</u>	<u>25</u>	<u>30</u>	<u>85</u>	<u>0.33</u>
4	<u>17</u>	20	22	17	76	0.30
5	7	3	2	9	21	0.08
>5	7	1	9	4	21	0.08
# of obs.	64	64	64	64	256	
mean offer	3.53	3.13	3.72	3.67	3.51	

Table 1a. Frequencies of the proposers' offers in each ER-session. The underlined numbers are modal frequencies.

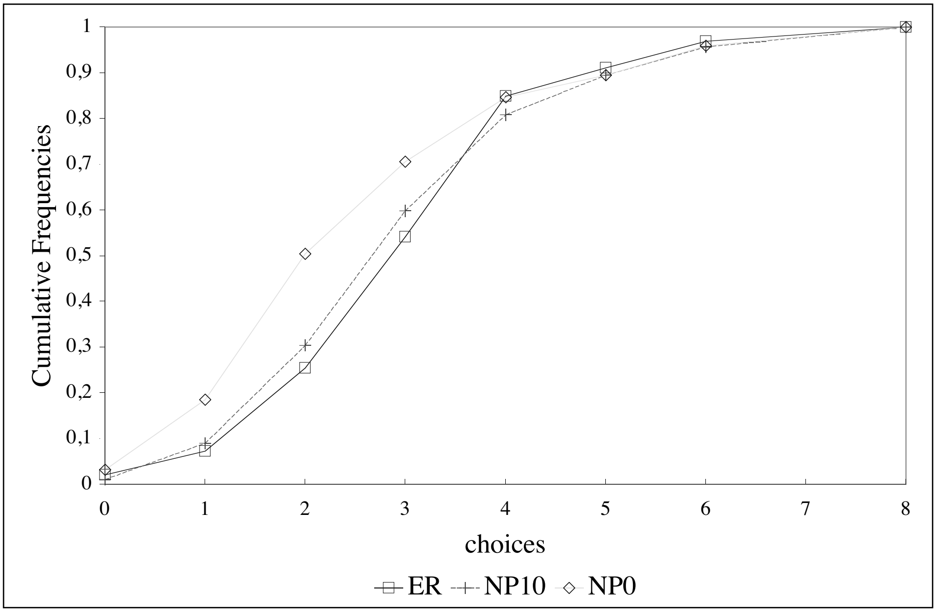
offer	NP10-sessions 5	6	7	8	total	relative frequency
0	0	2	1	0	3	0.01
1	0	11	6	3	20	0.08
2	1	<u>17</u>	<u>28</u>	9	55	0.21
3	15	16	12	<u>32</u>	<u>75</u>	<u>0.29</u>
4	<u>23</u>	9	10	12	54	0.21
5	13	4	2	3	2	0.09
>5	12	5	5	5	27	0.11
# of obs.	64	64	64	64	256	1.00
mean offer	4.34	2.92	2.86	3.44	3.39	

Table 1b. Frequencies the proposers' offers in each NP10-session. The underlined numbers are modal frequencies.

offer	NP0-sessions 9	10	11	12	Total	relative frequency
0	0	5	2	1	8	0.03
1	3	9	5	<u>21</u>	38	0.15
2	<u>17</u>	<u>25</u>	<u>21</u>	16	<u>79</u>	<u>0.32</u>
3	16	17	11	6	50	0.20
4	15	0	11	9	35	0.14
5	5	2	4	1	12	0.05
>5	8	6	10	2	26	0.10
# of obs.	64	64	64	56	248	1.00
mean offer	3.53	2.59	3.40	2.23	2.94	

Table 1c. Frequencies of the proposers' offers in each NP0-session. The underlined numbers are modal frequencies.

Figure 3. Cumulative relative frequencies of choices of proposers in all the treatments pooled over all periods

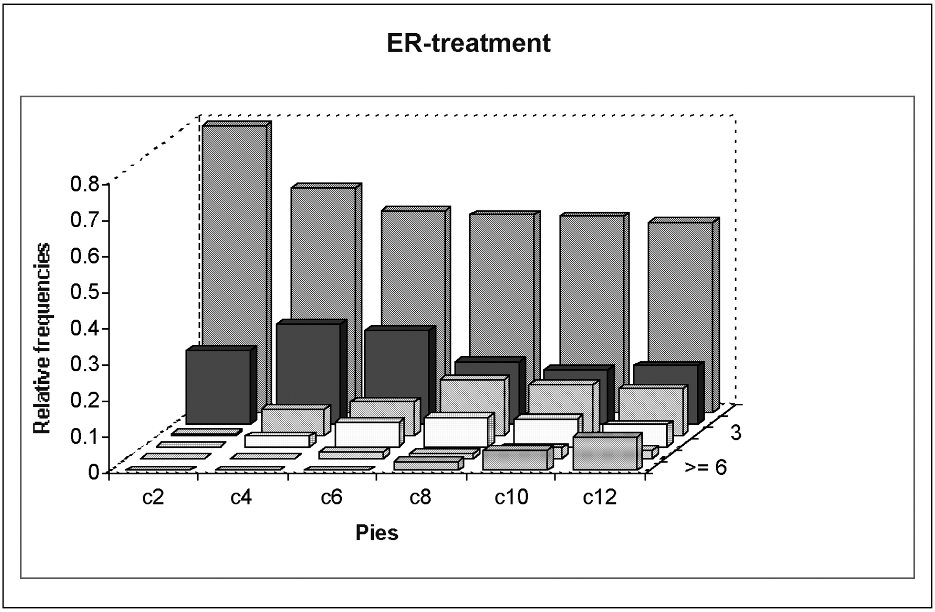


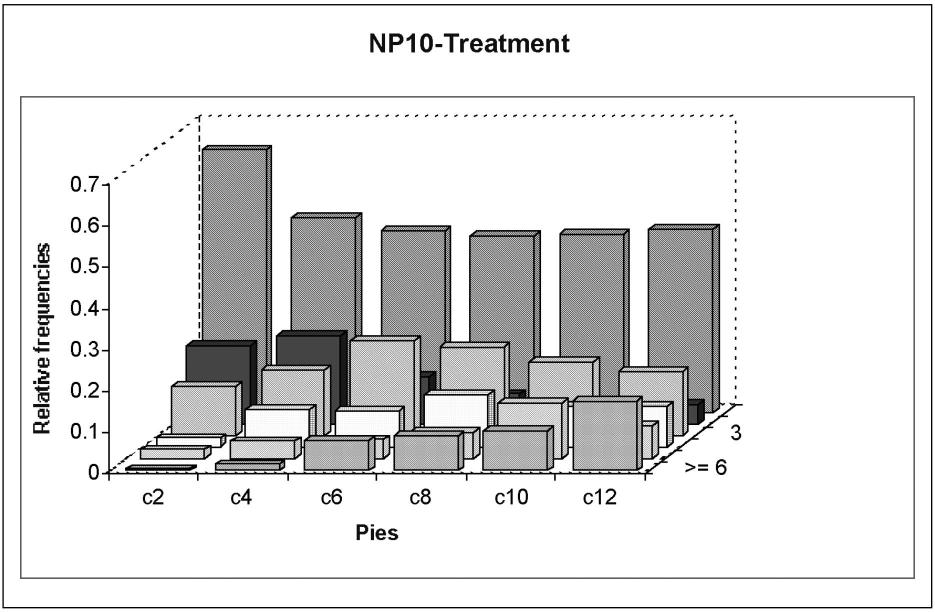
B. Mean choices of the responders

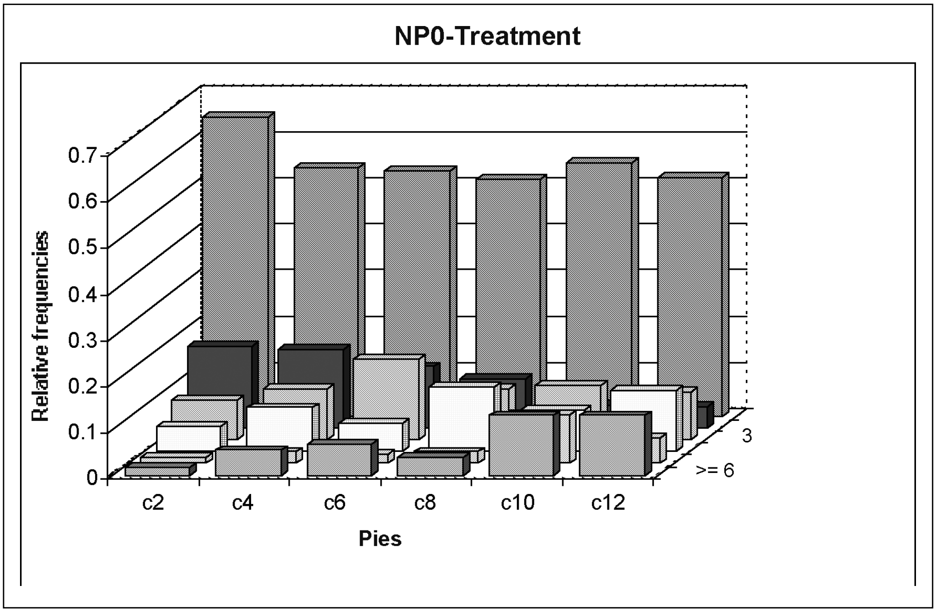
Here we only look at choices depending on the pie. Below we will classify the strategies of the subjects.

Figures 4 a, b, c show the frequencies of acceptance for each possible offer {0, 1, 2 ..., 5, > 5} at each pie {2, 4, ...12}, pooled over all sessions within a treatment (4 sessions x 8 players x 8 rounds = 256 observations per ER- and NP10-treatments, and 240 observations in the NP0-treatment since there were only 7 players on each side in session 12 and one decision sheet was lost in session 10).

Figure 4a-c. Relative frequencies of responders' minimal acceptance levels at all pies







In the ER-treatment and the NP0-treatment, about 50% would accept an offer 0 or 1 at all pies. In the NP10-treatment this frequency is about 40%. In all treatments at pie 2, about 80% accept 1.

The mean minimal accepted offer is strictly increasing with pie size in all sessions, except in sessions 9 and 10 (see table 2). The null hypothesis that there is no trend in these two sessions can be rejected in favor of the alternative hypothesis that the mean accepted offers are increasing, at the 5%-level, according to the Spearman-rank-correlation test. Thus, for the average behavior, payoff comparison plays a role for the responders, although the proposers do not know the pie size when making their decisions. Note also that the average behavior is not corresponding to any equilibrium strategy since in a Nash-equilibrium strategy the minimal accepted offer of the responder has to be constant across pie sizes.

Comparing the mean minimal accepted offers at each pie between the different treatments, those of the NP10-sessions are significantly higher than those of the ER-sessions at each pie, at the 2%-level for pies 2, 4 and 6 and at the 6%-level for the remaining pies, according to Mann-Whitney U-test. Across all pies there is a difference at the 2%-level between the two treatments. Thus, in the NP10-treatment the responders' average acceptance behavior (before knowing the actual offer of the proposer) is more aggressive than in the ER-treatment. Between the ER-experiments and the NP0-experiments there is only a significant difference at pies 2 and 4, at the 2%- and 5%-level, respectively, and no difference if one compares average behavior across the pies. Thus the responders treat the two treatments not differently, unlike the proposers. There is no significant difference between the NP0- and NP10-treatments.

Table 2. Mean minimal acceptance levels for the responders at each pie for each session, separately

Exp.#		Pie 2	4	6	8	10	12	Mean
ER-Sessions	1	1.14	1.34	1.63	1.73	1.98	2.14	1.66
	2	1.09	1.55	1.73	2.06	2.39	2.55	1.90
	3	1.03	1.34	1.58	1.73	1.78	2.05	1.59
	4	0.89	1.27	1.69	2.06	2.25	2.47	1.77
	Total	1.04	1.38	1.66	1.90	2.10	2.30	1.73
NP10-Sessions	5	1.23	1.75	2.28	2.67	2.95	3.14	2.34
	6	1.77	2.27	2.84	3.17	3.56	3.77	2.90
	7	1.39	1.69	1.89	2.03	2.13	2.25	1.90
	8	1.31	1.89	1.98	2.20	2.47	2.58	2.07
	Total	1.43	1.90	2.25	2.52	2.78	2.93	2.30
NP0-Sessions	9	1.86	2.84	2.69	3.14	3.08	3.48	2.85
	10	1.45	1.63	1.61	1.82	1.86	2.14	1.75
	11	1.58	1.75	2.11	2.25	2.61	2.73	2.17
	12	1.21	1.54	1.63	2.16	2.18	2.20	1.82
	Total	1.52	1.94	2.01	2.34	2.43	2.64	2.15

Result 2: The mean minimal acceptance level is increasing with respect to pie size in all treatments indicating payoff comparison's on the side of the responders, which is contrary to game theory. NP10 sessions show the highest means, thus most aggressive rejection behavior.

The average maximal accepted offers at all pie sizes correspond nearly to the maximal possible offer when comparing the results of the NP10- and NP0-sessions, there is no significant difference of average maximal accepted offers, according to the Mann-Whitney U-test. In the NP10-sessions, we observe 11% of the responders' strategies that reject or accept offers in a seemingly random way; in the NP0-sessions this frequency is 17%. About 20% of all strategies in both these treatments accept only offers up to an upper bound below the maximal possible. Three of those subjects explicitly wrote into the explanation sheet that they rejected offers higher than the pie size in order to prevent negative payoffs to the proposers. Three other subjects only accepted «middle» offers (between 3 to 7).

Result 3: 20% prevent negative payoffs to the proposer by rejecting offers above the pie size, which indicates that the responders do not care much about the proposers payoffs out of fairness consideration.

C. Acceptance rates and mean expected payoffs

In the following we calculate the acceptance rates of the responders at each pie, given the choices of the proposers and the resulting expected payoffs at each pie for both player groups.

The mean expected payoffs at each pie are calculated by matching[12] all the proposers' choices with all the responders' responses at each pie within the same period and experiment and taking the average across periods at each pie. The acceptance rate at a pie is calculated by the sum of expected payoffs of the proposers and the responders at that pie divided by the pie, thus, it is also the efficiency rate at each pie. Note, however, that the mean acceptance rate across pies is different from the efficiency rate across pies, which is the sum of average payoffs of both players divided by the expected pie size 7 (see numbers in parentheses in table 3).

Table 3 shows the acceptance rates at each pie for each session and also the means across pies. Tables 4 and 5 display the expected payoffs of the proposers and the responders, respectively. For the ER-treatment there is no coherent pattern between pie size and acceptance rate. On average, the highest acceptance rate is at pie 6 and 8. The reason is that in this treatment there are efficiency losses at pies 2 and 4 mainly because of nonfeasibility of high offers. At pies 10 and 12 low offers are more likely to be rejected. For all NP-sessions but session 10, the acceptance rates are decreasing with pie size (significant at the 1%-level for all NP-sessions, except for sessions 6 and 11, significant at the 5%-level, according to the Spearman-rank-correlation-coefficient test).

Result 4: Acceptance rates are decreasing with pie size in NP-treatments indicating that payoff comparison is important to the responders. At low pies offers are above half of the pie size but at high pies they are below.

[12] Mitzkewitz and Nagel 1993 were among the first who used such a calculation method, which was later more elaborated by Mullin and Reiley (forthcoming). The advantage is that means depend less on a specific match during the course of experiment.

The average acceptance rate at each pie between the NP10- and NP0-treatments are very similar. The acceptance rates at pies 6, 8, 10, 12 are significantly higher in the ER-treatments than in the NP0-treatments (at the 2%-level) and higher than in the NP10-treatment at pies 10 and 12 (at the 2%-level). The main reason for these differences are the higher offers in the ER-treatments than in the NP0-treatment and the higher willingness to accept in the ER-treatment than in the NP-treatments. At pie 2 the acceptance rate are always lower in the ER-treatment than in the other treatments because of non-feasibility of too high offers in the former. (And because of this non-feasibility the average acceptance rate across all pies is not different between the treatments).

A comparison of acceptance rates at the single pies between NP-treatments and demand-treatment (Mitzkewitz and Nagel 1994) also shows no difference, although the reason for high acceptance rates at low pies are distinct. In a demand game the proposers can ask for the entire pie with low probability of rejections since the responders cannot distinguish between modest and unfair proposals. In the NP-treatments the proposers offers at low pies tend to be larger than half the pie and thus are rarely rejected. At high pies, the proposers in demand games might try to take high stakes but this is perceivable by the responders in demand games and will be most likely rejected, as low offers at those pies are rejected in the NP-treatments.

Next, we consider expected payoffs for the players. As in the offer games, expected payoffs for the proposers are increasing with pie size. In NP10-experiments

Table 3. Expected rate of acceptance of the responders in %, given the proposers' offers, in each session. The numbers in parentheses are the mean efficiency rates

		Pie						
	Exp.#	2	4	6	8	10	12	Mean
ER-Sessions	1	32	66	76	76	75	77	67 (73)
	2	25	79	84	82	78	78	71 (77)
	3	07	71	88	89	88	84	71 (82)
	4	05	78	95	87	80	74	70 (78)
	Total	17	74	85	84	81	80	70 (77)
NP10-Sessions	5	93	96	87	79	74	72	84 (79)
	6	71	65	57	54	50	50	58 (54)
	7	87	81	76	69	66	65	74 (70)
	8	92	86	85	79	73	70	81 (77)
	Total	86	82	76	70	66	65	74 (70)
NP0-Sessions	9	74	64	64	64	61	57	64 (62)
	10	75	75	79	73	72	67	74 (72)
	11	85	81	75	73	67	66	75 (71)
	12	86	76	74	67	67	66	73 (70)
	Total	80	74	73	69	67	64	72 (69)

expected payoffs to the proposer are always below half the pie size. In the NP0- and ER-treatments, the proposers might get more than half at pies 10 or 12. In all negative-payoff treatments, at pie 2, expected payoffs to the proposers are negative. This again shows that the responders mostly do not reject those offers, which induce negative payoffs to the proposer. Of course the responders could argue that on average the proposers get positive payoffs.

The average expected payoffs in the blind-offer treatments are significantly lower than in the offer games (see Mitzkewitz and Nagel, 1993), at the 2%-level (ER-treatment), and at the 1%-level (NP-treatments), according to the Mann-Whitney U test. In comparison with demand games (see Mitzkewitz and Nagel, 1993), payoffs in the blind-offer games are of course lower for pies 2, 4, and 6, since in demand games the proposers ask for the entire pie at those pies and acceptance rates at those pies are high, but the reverse is true at pie 12 where the proposers obtain more in the blind-offer games than in the demand games. Across all pies the payoffs in the NP-treatments tend to be lower than in the demand games, significantly at the 5%-level. Hence, the proposers in offer- and demand games use their informational advantage for obtaining more than in the blind-offer treatments.

Result 5: Proposers receive lower payoffs in blind offer games than in offer or demand games with incomplete information on the side of the responders. Thus, in the later they can exploit their informational advantage.

Table 4. Expected payoffs for the proposers per period in each session

		Pie						
	Exp.#	2	4	6	8	10	12	Mean
ER-Sessions	1	0.07	0.77	2.06	3.48	4.87	6.34	2.93
	2	0.04	0.82	2.45	3.93	5.31	6.85	3.23
	3	0.00	0.47	1.99	3.74	5.41	6.83	3.07
	4	0.00	0.57	2.21	3.61	4.90	6.00	2.88
	Total	0.03	0.66	2.17	3.69	5.12	6.51	3.03
NP10-Sessions	5	-2.08	-0.34	1.35	2.80	4.09	5.49	1.88
	6	-0.89	0.38	1.39	2.39	3.23	4.25	1.79
	7	-0.90	0.73	2.15	3.22	4.42	5.69	2.55
	8	-1.38	0.37	2.04	3.45	4.58	5.81	2.48
	Total	-1.31	0.28	1.73	2.97	4.08	5.31	2.18
NP0-Sessions	9	-1.03	0.24	1.53	2.75	3.94	4.78	2.03
	10	-0.58	0.92	2.54	3.80	5.11	6.09	2.98
	11	-1.41	0.21	1.61	3.00	4.10	5.28	2.13
	12	-0.32	1.12	2.57	3.60	5.03	6.30	3.05
	Total	-0.84	0.62	2.06	3.29	4.55	5.61	2.55

Expected payoffs for the responders (see table 5) should not depend on pie size, but should be constant across pies, if payoff comparison did not matter and the responders were only interested in absolute payoffs. However, for the ER-treatment, average payoffs are highest at pie 8. The average payoffs within the NP-treatments are decreasing with pie size. Comparing average payoffs of the responders among offer or demand games and the blind-offer treatments, those of the latter are strictly higher than in the demand games. Thus, the responders profit when they obtain all information about the payoff allocation in comparison to the case where they can be easily exploited as in the demand game.

Result 6: Expected payoffs of the responders are decreasing in pie size in NP treatments. They are higher than in games with informational disadvantage to themselves (demand and offer games).

Note, that in all ER-sessions expected payoffs of the proposers are higher than those of the responders. However, in the NP-sessions, in 5 of 8 sessions, the responders obtain more than the proposers in expected payoffs. This has not been observed in any other ultimatum game experiment reported in the literature. Some subjects said that they were glad to be the responders or that they rather would have liked to be the responders. Thus, although the proposer has the advantage of making a proposal, because of insufficient information about the pie size, he might perceive himself in a weaker position.

Table 5. Expected payoffs for the responders in each session

		Pie						
	Exp.#	2	4	6	8	10	12	Mean
ER-Sessions	1	0.56	1.86	2.48	2.56	2.65	2.92	2.17
	2	0.45	2.34	2.58	2.65	2.53	2.52	2.18
	3	0.13	2.36	3.29	3.42	3.38	3.25	2.64
	4	0.09	2.56	3.51	3.34	3.13	2.91	2.59
	Total	0.31	2.28	2.96	2.99	2.92	2.90	2.39
NP10-Sessions	5	3.94	4.19	3.86	3.52	3.29	3.20	3.67
	6	2.30	2.22	2.02	1.94	1.79	1.77	2.00
	7	2.64	2.50	2.40	2.26	2.18	2.14	2.35
	8	3.22	3.08	3.07	2.91	2.69	2.60	2.93
	Total	3.02	3.00	2.84	2.66	2.49	2.43	2.74
NP0-Sessions	9	2.51	2.34	2.34	2.36	2.18	2.09	2.30
	10	2.09	2.08	2.18	2.02	2.07	1.95	2.07
	11	3.10	3.03	2.88	2.84	2.64	2.59	2.85
	12	2.04	1.92	1.89	1.73	1.68	1.66	1.82
	Total	2.44	2.34	2.32	2.24	2.14	2.07	2.26

D. Best reply payoffs for the proposers dependent on an offer

How does a potential offer perform against the actual strategies of the responders? Table 8 shows the mean expected payoffs within each experiment for each offer i = 0, 1, 2..., 6, calculated by matching an offer i with the actual strategies of the responders within each period and experiment and taking the average over the periods. The underlined payoffs are the highest payoffs when offering the same offer i in each period. We also give the actual mean expected payoffs of the proposers. Best reply payoffs are the expected payoffs if the best choice was offered within each period.

If the proposer chose the specific best-reply choice in each period, in the ER-treatment he would have obtained 3.75 on average whereas in the NP10- and NP0-treatments he could only receive 3.03 and 3.41, respectively. On average, across all NP10 and ER-experiments it is best to choose offer 3. Thus, as in the offer games half of the expected pie size is a good policy to follow. In the NP0-experiments on the other hand, in 3 sessions it is best to choose offer 1 and in one session it is offer 2. On average it is best to offer 1. *To our knowledge this is the first time that in ultimatum games it pays well to choose the equilibrium offer*. However, note that in all NP-experiments, but session 10, expected payoffs of best replies are lower than half of the expected pie size, whereas in the ER-experiments best-reply payoffs, are higher than half of the expected pie size for 3 out of 4 sessions.

Result 7: **Best reply offers are 3 in NP10 and ER sessions, which may correspond to half of the expected pie size and in NP0 it is the equilibrium offer 1!**

Table 6. Expected payoffs according to an offer, given the strategies of the responders' actual and best-reply payoffs, are also stated

	ER-sessions					NP10-sessions					NP0-sessions				
Offer	1	2	3	4	Total	5	6	7	8	Total	9	10	11	12	Total
0	0.22	0.45	1.36	1.20	0.81	0.94	1.54	1.38	1.11	1.24	0.90	1.89	1.10	1.78	1.42
1	4.26	2.62	3.07	3.05	3.25	2.95	2.03	3.03	2.71	2.68	2.80	3.53	2.68	3.02	3.01
2	3.71	3.67	3.49	2.69	3.39	3.07	1.90	2.83	2.49	2.57	2.65	3.16	2.90	2.73	2.86
3	3.54	3.54	3.47	3.05	3.40	2.55	2.29	3.13	2.94	2.73	2.34	2.94	2.77	2.70	2.69
4	3.02	2.87	3.17	3.09	3.04	1.94	1.96	2.67	2.66	2.31	2.12	2.38	2.44	2.24	2.30
5	2.28	2.29	2.57	2.58	2.43	1.52	1.58	1.83	1.88	1.70	1.47	1.67	1.73	1.64	1.63
6	1.80	1.74	1.93	2.00	1.87	0.91	0.83	1.01	0.97	0.93	0.82	0.85	0.98	0.86	0.88
Actual	2.93	3.23	3.08	2.88	3.03	1.88	1.79	2.55	2.48	2.18	2.03	2.98	2.13	3.05	2.55
Best-reply	4.27	3.74	3.72	3.28	3.75	3.22	2.45	3.28	3.15	3.03	2.88	4.03	3.13	3.61	3.41

E Strategies of the responders

In the following we structure the strategies of the responders. Before knowing the exact pie size within a round and the actual offer of a the proposer, the responder has to decide for each possible pie, which of all possible offers he is going to accept or reject. The rules of the game do not exclude that lower offers are accepted and higher offers are rejected at a pie. However, most of the strategies of the responders accept all offers above a minimal accepted offer (77% of all strategies, over all sessions).

Results 8: A large majority (77%) chooses a minimal acceptance level for each pie size and accept all higher offers.

As said above 20% of those who reject offers above a minimal acceptance level do so in order to prevent negative payoff to the proposer (rejection of offers larger than a given pie size). Additionally, it seems sensible to consider *monotonic* strategies, i.e. with increasing pie size the minimal accepted offer remains the same or increases.

In the following we classify those strategies that are monotonic in minimal acceptance level, but non-monotonic in acceptance behavior at a specific pie (in fact, 12% of all strategies reject offers above the minimal accepted offers at some pies and have monotonically increasing acceptance levels).

Category 1 specifies those strategies that have the *same* minimal acceptance level for each pie, thus the acceptance level «L» is *independent of the pie size* (L_i=L, i ? {2, 4, ..., 12}, where i is the pie size). Within this category are L=0 or L=1, the dominant strategies, L=2, L=3, etc.

Category 2 includes strategies for which the acceptance level is *pie dependent*. A typical benchmark acceptance level is the «level equal half of the specific pie». Within category 2 we distinguish between those strategies where the acceptance levels are pie dependent and all minimal acceptance levels are smaller or equal half of the pie size ($L_i \leq$ ½·pie i, but not all L_i= ½·pie i, *category 2a*) and those were acceptance level is greater or equal half of the pie ($L_i \geq$ ½·pie i, *category 2b*). The strategy, «L_i= ½·pie i for all i, belongs to category 2b. Those strategies that have some acceptance levels below and some above half of the accepted pies are classified as others *(category 2c)*.

Category 3 includes all strategies that are not monotonically increasing in the minimal acceptance level, or have no specific pattern, i.e. random strategies.

Table 7. Relative frequencies of the responders' strategies according to the typical strategies within each treatment, separately

	ER-TREATMENT				NP10-TREATMENT				NP0-TREATMENT			
	Perfect hit	up to ... deviations			Perfect hit	up to ... deviations			Perfect hit	up to ... deviations		
		One	Two	Three		One	Two	Three		One	Two	Three
Category 1												
(L_i=L=0;1)	0.44	0.44	0.44	0.45	0.35	0.35	0.35	0.35	0.40	0.41	0.41	0.42
L_i=L=2	0.07	0.09	0.09	0.10	0.02	0.03	0.04	0.06	0.03	0.03	0.15	0.15
L_i=L=3	0.02	0.02	0.04	0.07	0.01	0.09	0.11	0.13	0.01	0.06	0.07	0.08
L_i=L=4	0.03	0.03	0.03	0.03	0	0	0	0	0	0	0.01	0.03
total	0.56	0.58	0.60	0.65	0.38	0.47	0.50	0.54	0.44	0.50	0.64	0.68
Category 2a $L_i \leq ½ \cdot pie_i$	0.28	0.30	0.34	0.34	0.16	0.21	0.22	0.22	0.11	0.16	0.19	0.19
Category 2b $L_i \geq ½ \cdot pie_i$	0.05	0.06	0.06	0.06	0.12	0.16	0.19	0.20	0.07	0.10	0.10	0.10
Category 2c Others	0.07	0.05	0.00	0.00	0.23	0.05	0.00	0.00	0.21	0.10	0.00	0.00
Non-monotonic	0.05	0.05	0.05	0.05	0.11	0.11	0.11	0.11	0.17	0.17	0.17	0.17

Table 6 shows the frequencies of strategies for all three treatments according to the classification scheme (column «perfect hit» are those frequencies which conform exactly to one of the classifications). As in Mitzkewitz and Nagel (1993) for the classification of the strategies of the proposers we also count the strategies that are in the neighborhood of the typical strategies. The neighborhood is specified by no more than one integer-deviation, no more than two integer-deviations, or no more than three integer-deviations from the typical strategies. Each deviation of an acceptance level is constrained to the next higher or next lower integer offer and the strategy is monotonically increasing in the acceptance level. (The frequencies of the 2nd, 6th and 10th column of table 6 are those frequencies with perfect hit, columns 3, 7, 11 are those with up to one deviation etc., for the different treatments). For the strategies in the neighborhood of category 2a with one deviation, for example, this means that L_i = ½·pie i +1 for one i and $L_j \leq$ ½·pie, for j ≠ i (but not all L_j= ½·pie j). For the strategies in the neighborhood of category 2b, no more than 3 levels may be ½·pie - 1 and not all other levels equal half the pie. Most of those strategies in the neighborhood of strategies with constant minimal acceptance levels have typically only two acceptance levels e.g. 2, 2, 3, 3, 3, 3 for the pies 2 to 12.

Table 8. Frequencies in % of dominant strategies of the responders in each session for blind-offer, offer, and demand games

	Offer	Demand	ER	NP10	NP0-
	42.2	9.3	48.3	47.1	29.7
	59.4	31.3	57.8	20.3	45.0
	45.3	23.4	32.8	34.4	40.6
	42.2	12.5	39.1	41.0	53.6
	67.1	43.8	--	--	--
Total	51.3	24.1	44.5	35.5	41.7

In the ER-treatment, more than half of the strategies have pie independent acceptance levels (56%) (see table 6). In the NP-treatments, allowing up to one deviation about half of the observations are in the neighborhood of pie independent strategies (47% in the NP10-treatment, and 50% in the NP0-treatment). As in the offer games, the dominant strategies (strategies that accept all (positive) offers) are the prevailing strategies in all treatments (44% (ER), 36% (NP10), and 42% (NP0), allowing up to three deviations from the dominant strategy). Note that these average frequencies are slightly lower than in the offer game (51%), but higher than in the demand game (24%), (see Table 7, for the frequencies of the dominant strategies for each session in each treatment (offer and demand game results are also stated). A comparison with dominant strategy frequencies of experiments on the ultimatum games with complete information (Harrison and McCabe 1992) shows that the frequencies (about 17%, 13%, and 39%, 40%[13]; we added the frequencies between an accepted share of 0 and 15% and averaged those of the first 8 periods for each of 4 different experiments) are similar as in the demand games and all of them are lower than those of the offer game and of the ER-sessions. We have already noted in Mitzkewitz, Nagel (1993) that as the possibility of payoff comparison for the responders decreases the willingness to adapt to the dominant strategy increases. We can now add that it also makes a difference for the responders whether he knows that the proposers cannot make payoff comparisons - low offers are then more likely to be accepted than in the complete information case.

[13] The high frequencies of the latter two experiments can be attributed to the feature that the strategies of all players were displayed in public after each period.

Result 8: Dominant strategies (i.e. no pie dependency and accepting all positive offers) are the prevailing strategies in all treatment, with a percentage 3 to 4 times higher than in complete information games. Such high percentages are observed whenever one side (the proposer or the responder) cannot realize what a fair offer is.

The strategy with the second highest frequency in all treatments is those strategies that are pie dependent and with acceptance levels smaller half the pie (34%, 22% and 19% allowing up to three deviations). Note that in the ER-treatment there are only a few strategies that reject offers smaller than half of the pie (6%, category 2b). Those frequencies are highest in the NP10-treatment. We have already mentioned that the responders in the NP-treatments are more aggressive in acceptance behavior than in the ER-treatments.

Result 9: The second highest frequency of strategies are those that include acceptance level less than half the pie size, but not the same minimal level for each pie.

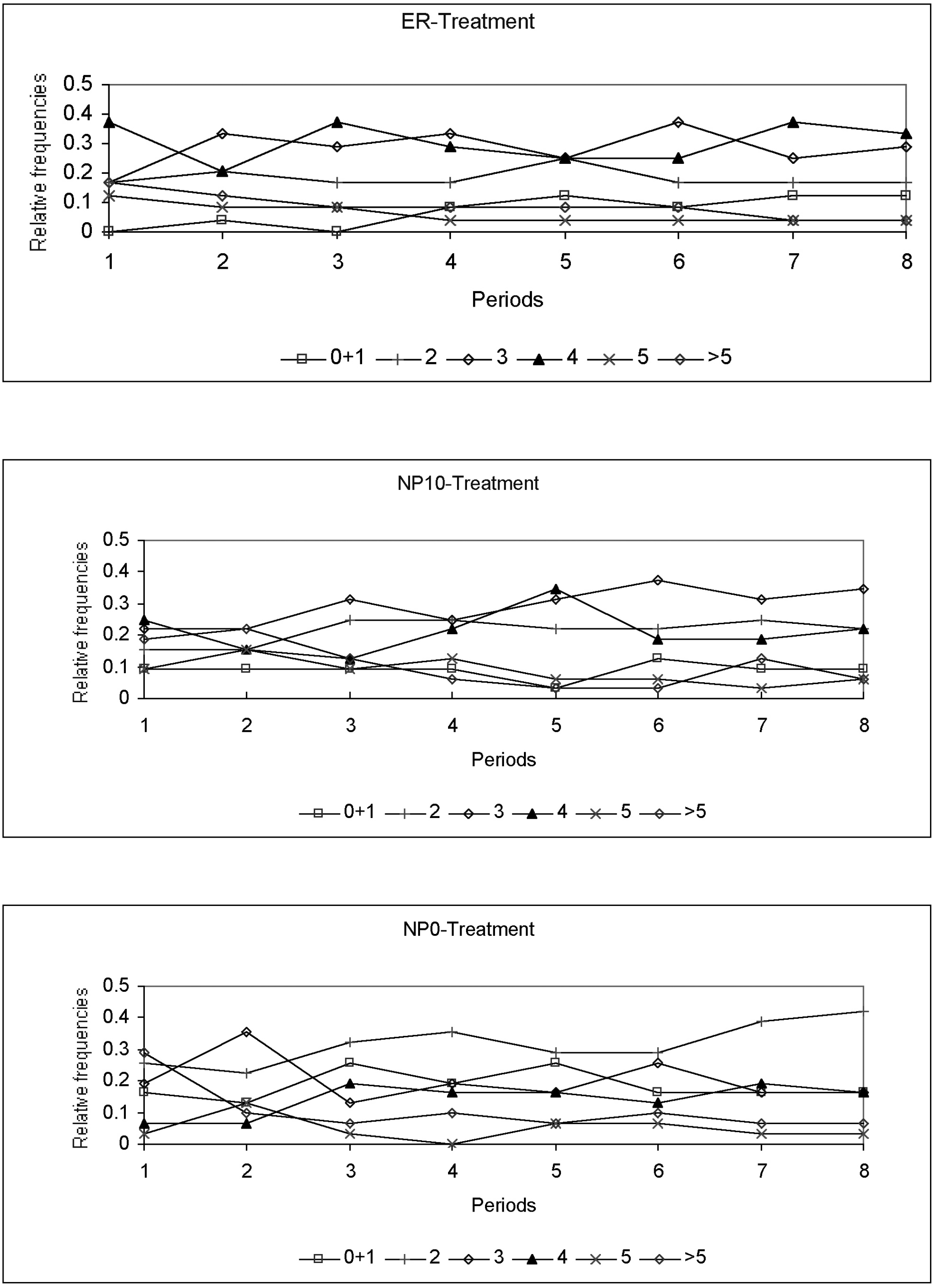
5. Dynamics of the behavior over time

A. *Choices of the proposers over time*

Figures 5a,b, c plot the frequencies of choices over time. In ER-treatments, offers 3 and 4 remain the prevailing strategies over time. In the NP10-experiments mainly offer 3 predominates, followed by offer 2. In the NP0-treatments it is offer 2, followed by either 1 or 3. Only in the latter the equilibrium offers have a frequency of more than 15% in all but one period (here we have aggregated offers 0 and 1). Thus, the modal offers comply with best replies, as calculated above.

In the NP-treatments choices > 5 have the highest frequencies of all offers in the first or second period. This might indicate that some subjects take the midpoint of possible choices from 1, 2,..., 12 as a «focal point». However, those choices decrease to fewer than 10% in the subsequent periods, which is similar as the dynamics of the 50-50 strategies in the offer games. Those «nonstrategic» choices or «midpoint» choices are observed in many experiments in the opening rounds (see, e.g. a survey on public goods experiments by Ledyard, 1993). Note, in complete information ultimatum games the equal split strategy remains the most frequently used strategy (see, Roth et al. (1991) and Harrison and McCabe (1992)).

Figure 5a-c. Relative frequencies of offers over time

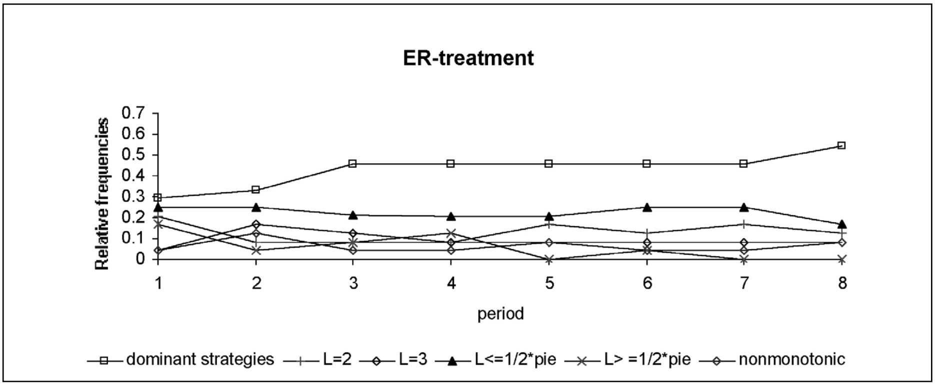


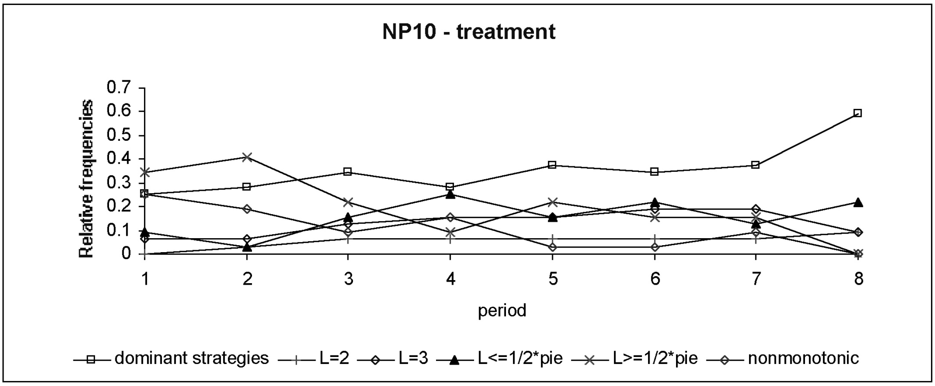
B. *Strategies of the responders over time*

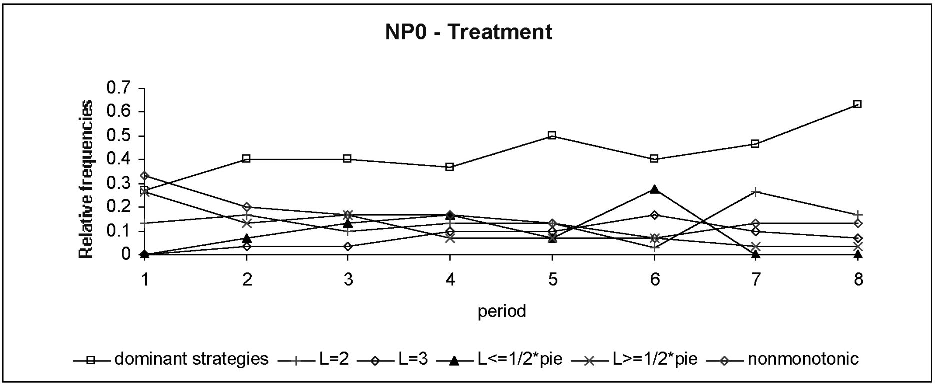
Figures 6a,b, c show the relative frequencies of the responders' strategies over time as classified above, separately for each treatment. The frequencies of the dominant strategies prevail over time in all treatments and increase over time. Also the sharp increase in the last period is notable, which we also observed in offer games. The frequencies of the dominant strategies over time in the offer version of Mitzkewitz and Nagel (1993) are slightly higher than in any blind offer version, especially in the first two periods (about 40%). In the blind-offer games only 30% accept all offers in the beginning. In offer games the responder cannot compare payoffs at all, therefore he is more easily inclined to accept all positive offers right from the beginning. Looking at the dynamic structure of the «at least fifty-fifty request» ($L_i \geq ½ \cdot pie_i$), those frequencies are rather small (below 16%) in the ER-case in all periods. However, in both NP-treatments in the opening periods, we observe a frequency of about 30% of those strategies, which are also among the modal frequencies. Harrison and McCabe (1992) observed this phenomenon. Thus, as in many other experiments we observe that many subjects start out with equal split considerations, or more generally speaking with some midpoint of the strategy space when the game structure is not yet clear to them. Only experience, most likely negative experience, might lead them away from such a strategy or choice (less than 20% after the opening periods in our study). In the Harrison et al. study, for example, still about 40% of the responders ask for equal splits in the 8th period when they do not get any information about the outcome in a period.

In the following we analyze the mean behavior of both player groups over time. We calculate the mean offer of all the proposers within each period and experiment. For the behavior of the responders over time, we define a *rejection index,* as the number of offers rejected *below the lowest accepted offer* at each pie. Thus, we neglect the fact that some players reject offers above their minimal accepted offers. Here, we are only interested whether there is a decrease or increase of the lowest accepted offer. Table 9 presents the Spearman rank-correlation coefficients between the periods and the players' mean behavior in a period in each experiment. A positive coefficient for the proposers' behavior means that the offers decrease over time and for the responders it means that the rejections decrease over time.

Figure 6a-c. Relative frequencies of responders' strategies over time







Concerning the proposers' behavior, in 9 out of 12 experiments the Spearman rank-correlation coefficients are positive and in five of those the increase is significant. According to the Binomial test the null hypothesis that positive and negative coefficients are equally likely (i.e., that there is no tendency in either direction) cannot be rejected. Regarding the responders behavior, the same null hypothesis can be rejected at the 5%-level: all but one of the correlation coefficients are positive, thus there is a decrease of rejections. The decrease is significant in 7 experiments, according to the Spearman rank-correlation test.

Table 9. Spearman rank-correlation coefficients be-tween round and the proposers' mean offer, and round and the responders' rejec-tion index

	The proposers' decrease of offer		The responders' decrease of rejec-tions	
ER 1	+.71	*	+.85	**
2	+.71	*	+.52	
3	+.34		-.12	
4	+.67	*	+.81	*
NP10 5	+.78	*	+.95	**
6	+.83	**	+.36	
7	-.17		+.99	**
8	+.52		+.77	*
NP0 9	+.63		+.71	*
10	-.10		+.59	
11	+.94	**	+.91	**
12	-.73	*	+.10	

* Significant on 5% level, ** significant on 1% level

In the working paper version we show how offers and rejection behavior depends on the one period lag history of a single player. As in Mitzkewitz and Nagel (1993) one can see that offers increase when they are rejected in the previous period. However, players who receive negative payoffs or offered non-feasable offers (in ER) most strongly decrease their offers. Rejection levels decrease most likely when offers got rejected.

6. Discussion and summary

All ultimatum games, we have analyzed experimentally, have extreme path-strict equilibrium predictions, i.e., the responder obtains the smallest money unit and the proposer obtains the remaining share of the pie. Also the off-equilibrium paths are similar, with the main exception that in one game negative payoffs may occur.

The nonfeasible treatment (ER), in which the opportunity to divide the pie disappears, when the offer is greater than the pie, resembles the offer game of Mitzkewitz and Nagel (1993) with respect to the feature that the proposer may not offer more than the pie available. Although the information structure for the proposer is different between the ER-treatment and the offer game, the behavior of the proposers and the responders is similar to that in the offer game:

— The proposers in both information structures most frequently choose an offer of half of the expected pie size.
— Best reply offers are on average based on the concept of half the expected pie.
— Only a slightly lower percentage of the responders accept all positive offers in ER-treatments (44%) than in the offer games (51%). We were quite surprised by this result since we expected that the frequency of behavior would look like the one in demand games, with low observations of dominant strategies (24%). It seems that many responders take into account that the proposers do not know the pie size.

The behavior in the negative-payoff treatment with no starting capital allowance is significantly different to the behavior in the nonfeasible treatment:

— offers are significantly lower, with many offers near the equilibrium (offer 2), which we interpreted as loss avoidance.
— average best replies are at or near the subgame-perfect equilibrium choices. This has not been observed in other ultimatum games studied experimentally so far.

Among the blind-offer games, the highest frequencies of dominant strategies of the responders were observed in the ER-treatment, right from the beginning. In the NP-treatment on the other hand, strategies that rejected offers below half of the pie were widely observed in the opening periods; however, they decrease over time. This may indicate that the responders start with fifty-fifty considerations because the strategy space suggests that at each pie as many as 12 talers could be offered to them. Over all periods the responders play more aggressively in the negative-payoff treatments than in the ER-treatment. Never before it happened in any ultimatum game experiment that the proposers might obtain less than the responders, as it we observe in some NP-sessions.

Note, that in the discussion of considerations of fairness (see, e.g. Roth 1995), it was mainly a question whether the proposer wanted to treat the responder fairly, i.e., to give him a substantial split of a pie. Here, we can also studied whether the responder wants to treat the proposer fairly, i.e., to prevent the proposer from negative payoffs. The fact that only few of the responders prevent the proposers from negative payoffs shows that the responders are mainly interested in their own payoffs. However, the increasing average acceptance level confirms that payoff comparisons also play a role, although the proposer does not know the pie size. This confirms the model by Bolton and Ockenfels (1999) that relative payoffs matter.

Interestingly, a pairwise comparison of average acceptance rates across pies in different treatments - offer and demand games (of Mitzkewitz and Nagel 1993) and the different blind-offer games - shows no significant difference, according to the Mann-Whitney-U-test. Roth et al. (1991) made a similar observation in their multicultural experiment. Although the offers between countries were different, the average acceptance rates of the countries were astonishingly similar. This is particular striking since the modal behavior of the proposers in games with different information structures is different. This indicates that the proposers and the responders respond in a «correct way» to the information structure. When the proposers can offer less, responders might not realize this and thus are more inclined to accept.

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Appendix I

Instruction sets for the blind-offer games

When reading the instructions (the same for player A and B) each subject had a copy of the instructions, sample decision and record sheets. Questions concerning the rules of the games were answered. After the instructions were read, each subject was randomly assigned to be always in the role of player A or player B. They then obtained the corresponding decision and record sheet and an explanation sheet, with a fictitious name on them. They were handed to them in such a way that neither our assistances nor the experimentators could identify a decision sheet with the corresponding subject.

Instructions

Sixteen persons have volunteered to participate in the present study.

The experiment consists of 8 rounds. 8 of you will participate as «player A» and 8 of you as «player B». In each of the 8 rounds each player A interacts with another player B - thus no player A will meet the same player B again. At the end of the instructions it will be randomly decided who will be in the role of player A and who will be in the role of player B.

In each round of the 8 rounds a certain total amount in Talers (fictitious currency) is to be divided between a player A and a player B. This amount is determined by the throw of a die, and multiplying the thrown number by 2. Thus, the total amount can either 2, 4, 6, 8, 10, or 12 Taler. Players A only knows that the amount can be either 2, 4, 6, 8, 10, or 12 with equal probability, but he does not know the exact total amount. Player B's decision is based on knowing the total amount.

It is the task of player A, who does not know the exact total amount, to make a proposal which amount in Taler he is going to offer to an anonymous player B.

— If the offer is **less than or equal** to the total amount thrown, player B decides whether to accept the offer or reject the offer. If B accepts, B gets the offer and, in this event, A gets the difference between the total amount (as determined by the throw of the die) and the offer. But, if B rejects both persons A and B earn nothing.
— If the offer is **higher** than the total amount of that round, then both players get nothing.

For the offer, player A has to follow certain rules:

— The offer must be an integer, that is offers of 0;1;2;3;4;...to 12 (the highest total amount) are possible.
— Player A writes his offer in his decision sheet of the respective round. (see decision sheet of player A).

Player B has to decide whether he accepts or rejects an offer of player A. For his response, person B also has to follow certain rules:

— Player B has to make his decision in advance, before the die is thrown and before he obtains an offer from player A. This means that player B has to decide *in advance* for each possible total amount 2, 4, 6, 8, 10, and 12 which possible offers of player B he is going to accept or reject. He indicates this on a decision sheet. (See decision sheet player B).

Once all players have completed their task of the round, then all decision sheets of players A and of players B will be collected. Then a die is thrown which determines the total amount of money available in that round. Each offer of player A will be matched with a decision sheet of a player B.

— If the offer was **higher** than the amount thrown, the opportunity to split the total amount disappears. This means that both players receive nothing.
— If the offer has been rejected, again the opportunity to split the total amount disappears; thus both players receive nothing.
— If the offer has been accepted, player B earns the offered Taler and player A receives the total amount minus his offer of that round.

On an extra record sheet of each player the total amount of the round, the specific offer of player A, the specific answer of player B and the resulting gains of the round will be written. (See record sheet).

Afterwards the decision sheets and record sheets are returned to the players.

Between the rounds you are invited to explain your decisions on an explanation sheet (motives, aims etc.).

After 8 rounds your gains of the rounds will be added, the talers are converted to DM with exchange rate: 1 Taler = *0,70* DM and paid to you.

It will be randomly determined who will be player A and who will be player B.

Each player receives an decision and record sheet with a fictitious name on it, in order provide anonymity. When we see your decision we will not know nor care who did what.

If you have any questions concerning the rules of the game please ask them now.

Instructions for the negative payoff treatment without starting capital amount

[We only give the differences to the previous instruction]

...

It is the task of player A, who does not know the exact total amount, to make a proposal which amount in Taler he is going to offer to an anonymous player B. Player B decides whether or not to accept the offer.

— If player B accepts the offer and the offer
  - is **less than or equal** to the total amount thrown, B gets the offer and, in this event, A gets the residual of the total amount, the difference between the total amount (as determined by the throw of the die) and the offer.

— If player B accepts the offer and the offer
  - is **higher** than the total amount of that round, then player B gets the offer and player A gets the loss, the difference between the total amount and the offer.

— If B rejects, both players A and B earn nothing.

...

Each offer of player A will be matched with a decision sheet of a player B.

— If the offer was accepted, player B gets the offered Taler and player A gets the difference between the total amount and the offer. The difference is negative, if the offered amount is greater than the total amount and is positive if the offered amount is smaller than the total amount.

— If the offer has been rejected, the opportunity to split the total amount disappears; thus both players receive nothing.
— If the offer has been accepted, player B earns the offered Taler and player A receives the total amount of that round.

...

Each player gets a starting capital balance of 10 Taler. After 8 rounds your gains are added to the 10 Talers and losses are subtracted...

If the sum of the gains and losses of a player after any round is equal to the loss of ten talers or more, then this player is excluded from further rounds of the experiment.

...

Instructions for the negative payoff treatment with starting capital amount to both players. Only the last two paragraphs differ from the instruction of negative payoffs with starting capital balance.]

…

After 8 rounds your gains are added and losses are subtracted. The talers are converted to DM with exchange rate: 1 Taler = *0,70* DM. If the total sum is negative, you have to put the amount into a box which will be provided to you. If the sum is positive you get this sum...